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CEMENT

Production of portland cement has become one of the state's foremost mineral industries. The value of cement produced in California in 1953 reached $90,870,000 and now is second only to the value of California petroleum products. The cement plants are grouped around the two principal marketing areas--Los Angeles and San Francisco--and lie within a radius of 125 miles of one or the other of these centers. Most of the mineral material consumed by these plants is obtained close to them and all but an insignificant proportion of raw materials consumed are obtained from sources in California. The supply of California raw materials suitable for portland cement is nearly inexhaustible, but some deposits are less conveniently situated than those now being exploited.

The Nature of Portland Cement

Portland cement is the chief binding agent used in modern concrete and is also an important constituent of mortars and plasters used by the construction industry. Its most useful characteristic is the ability to set into a stable binder in the presence of water. Portland cement is manufactured by calcining, and heating to incipient fusion, under carefully controlled conditions, suitable mixtures of finely ground raw materials that include as essential ingredients calcium carbonate ($CaCO_3$), silica (SiO_2), and alumina (Al_2O_3). Iron oxide is also an important constituent in several types of cement, particularly the sulfate-resistant types. With the exception of white cement, in which the iron content is kept well under one percent, portland cements generally contain some iron oxide (Fe_2O_3). Blended portland cement mixtures ready to be fed into the kilns generally lie within the following chemical limits (dry basis).

Lime (CaO)	60-64%
Silica (SiO_2)	20-24%
Alumina (Al_2O_3)	6-10%
Iron oxide (Fe_2O_3)	3- 5%
Remainder (includes magnesia (MgO), alkalies such as potash (K_2O) and soda (Na_2O), and uncombined raw materials).	less than 4%

The degree of variance within these ranges depends upon the type of cement being produced and the available raw materials.

During the burning operation the pulverized raw materials are converted into cindery particles or clinker composed of new, anhydrous, lime-bearing compounds with loss of a large volume of carbon dioxide-about 35 percent of the raw mix (dry basis). A typical Type I clinker has the following analysis:

Silica (SiO_2)	21.3%
Alumina (Al_2O_3)	6.0%
Iron oxide (Fe_2O_3)	2.7%
Lime (CaO)	63.2%
Magnesia (MgO)	2.0%
Sulfur trioxide (SO_3)	1.8%
Ignition loss	1.3%
Insolubles	0.2%
Total	98.5%

Portland cement is made by grinding the clinker to a very fine powder. A small amount of gypsum, about 11 pounds per barrel, is interground with the

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